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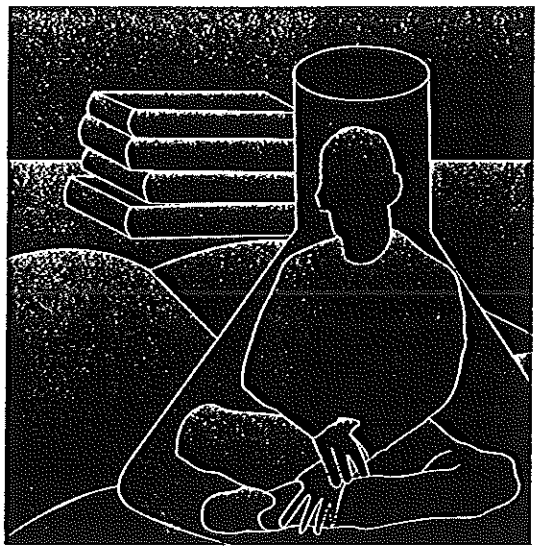
Research Developments

Experimental Methods in Economics and Political Science: The Design and Testing of Policy Options

Designer markets are becoming a reality: theoretical developments in economics and political science are now being combined with advances in laboratory technology to produce new uses of basic science and a new approach to policy. In essence the approach is similar to that of engineering, in which scientific principles and practical knowledge from laboratory experiments are used to design systems or devices to perform a specific function. The new research efforts can be understood as involving a design methodology in the truest sense of the word. Policy issues are first cast as problems of decision process design and the architectures of decision mechanisms are then built on basic research foundations. Refinements and adjustments to institutions, organizations and procedures—which provide strength and desirability to a policy process—are then added as a result of the practical experience provided by laboratory experimentation and testing. The practical experience and testing are achieved by involving real people in controlled exercises that carefully replicate the constraints, the freedom for individual initiative, and the potential rewards of the process under test.



The basic methodology is so simple it would seem unworthy of statement. First, many policies involve the establishment of a process through which relevant economic decisions are to be made. An example might be a proposed national policy on reducing air pollution that changes the process through which emission decisions are made from one involving centralized administrative review to one based upon the decentralized purchase or sale of permits.

Such processes, called "mechanisms" in the technical literature, are the focus of the research. To achieve the desired results from the operation of a process, the individuals working within it should not be required to make decisions that are at odds with their own self-interest. The mechanism must be incentive compatible and the multitude of individual decisions must be properly coordinated. It sounds like common sense, but in the context of the operations of a mechanism, with a possibly large number of strategically interacting individuals, the relationships can become very subtle and complex. Institutional features that might appear innocent or irrelevant can have profound influences on the ultimate decisions. Tools are needed to gauge process performance. Models of behavior are needed to provide an understanding of the choices that might evolve from the mechanism once it is in place. A methodology for testing is needed to determine if the mechanism really works as theory suggests.

The approach has roots in several disciplines. The focus of policy research on the study of decision-making processes—as opposed to a traditional focus on particular decisions and the personalities of important decision makers—comes from the field of Public Choice. The substance of Public Choice theory is that public decisions are as much a product of the mechanism through which decisions are made and expressed as they are a product of the personalities of the individuals in the decision-making organizations. Public Choice, together with the more technical field of Social Choice theory, provide additional tools that facilitate the evaluation of the products of policy processes.

Social Choice theory provides both a concept of efficient social choices and also the tools for measuring the outputs of the mechanism in order to determine the degree to which normative goals of a process are attained. Given limited options, a pattern of conflicting preferences over options, and

a pattern of information, does the process produce the proper result? The measurement, carried out by observing the decisions of real people, is objective and not necessarily related to whether or not people are happy with the process or feel good about the outcome.

The disciplines of economics and political science provide sets of principles that are based on the purposeful behavior of individuals. Theories from these disciplines provide connections among the choices of individuals and the overall performance of the decision process, which can depend upon hundreds of such individual decisions. The theories characterize the relationships among individual motivations and choices and the resulting system behavior. A special set of tools, provided by game theory, connects institutions and the information available to an individual at the moment of decision and integrates these with strategic behavior.

A major new tool that gives the overall approach a sense of newness is provided by rapidly-developing laboratory experimental techniques. Through these techniques, real people are used to make real decisions to explore and establish patterns of individual and group behavior. Substantial financial incentives (that are actually paid) are used as a source of motivation of subjects. The value that people place on the outcomes of policy is replaced in the laboratory by a possible financial payment that an individual, depending upon the outcome of the process, can accrue. With the control provided by incentives, conflicts across the objectives of different individuals can be induced; and, simple mechanisms for resolving the conflicts can be implemented in a laboratory environment and in a manner that is theoretically understandable.

The lessons of an experiment are derived from the fact that general theories should work in simple, special cases. If they do not, then they can be rejected as being general. Simple, special case, laboratory processes are thus an appropriate testing ground for general theories about behavior. For example, experimentalists in the field of economics can create simple markets in which, theoretically speaking, the law of supply and demand (and various incarnations of the law) can be observed in operation. In fact, such models do indeed operate and with a great deal of accuracy. Small group experiments, to which models from game theory can be applied, provide an opportunity to test theories of strategic behavior such as the Core, Bargaining Set, and theories of voting behavior.

Many replications of experiments involving different subject pools, experimenters, societies, countries and differing experimental procedures have provided evidence that the behaviors observed in laboratory experiments are a consequence of the decision mechanism and not the special characteristics of subjects involved or laboratory procedures used. Theories of economics and political science have been substantially influenced by the data from such laboratory experimentation: one result is that many of the basic principles found in the literature are backed by solid experimental data. The study of simple cases has revealed the nature of errors and inaccuracies of theories; and in response to the data, the theories have been modified and improved.

The step from basic laboratory science to the application of laboratory methods to policy is a big one. The process is facilitated by applying "experimental testbedding" in which a policy is implemented in a laboratory environment. The lessons learned from a "testbed experiment" follow the same logic as do basic scientific endeavors. If a postulated policy process does not work in a very simple laboratory testbed environment then it is not reasonable to expect it to work if implemented in a complex field setting. Thus, the laboratory exercise can be employed as a "proof of principle." Moreover, if a policy operates acceptably in a testbed environment it must do so for theoretically understandable reasons. Formally speaking, the policy must pass a test of "design consistency" in which it is demonstrated that the behavior of the process is consistent with the behavioral principles upon which it is built. If the behavior of the policy is acceptable, but not understandable, then there is no

ground for believing that the policy would operate the same way in theoretically similar, but different environments.

The testbed need not be limited to the investigation of single processes. The methodology provides a tool for testing competing policies by observing their operation in identical environments. New policies can evolve from combinations of those that were tested. At a minimum the data from laboratory contexts places a burden on advocates of a losing policy to explain why the evidence should be ignored or what type of testbed might yield different results.

As a practical matter experimental testbeds also provide a tool for discovering policy "bugs." Implementation of a policy means that every feature must be made operational: exactly who does what and when must be specified. Who signs what and who is informed about what and when are all important details that can have pronounced influences on behavior. This forcing of detail, commitment to detail, and interaction of detail with ensuing behavior can uncover problems that could cost millions of dollars to rectify were the policy implemented in today's litigious society, without prior testing.

An example of the application of testbed methodology is an issue that is now under consideration by the Federal Communications Commission (FCC): a new federal policy to privatize rights to use the airwaves for personal communication devices such as cellular telephones. In essence, the Commission has decided to auction off the electromagnetic spectrum and allow market processes to replace many of the administrative review processes that have been utilized in the past. The FCC would like to conduct the sale as soon as possible but a controversy has challenged the rules of the auction. A total of about 2500 possible licenses exist. The plan proposed by the FCC is to sell two licenses in each of 51 extensive regions in the United States called "major trading areas" (MTAs) and to sell five additional licenses in each of 492 smaller areas called "basic trading areas" (BTAs).

The question posed for testbed research is how the FCC can most responsibly auction the spectrum in a way that allocates a scarce and potentially profitable resource in a way that will create the most value to the nation. The number of ways that the licenses might be allocated among competing firms number literally in the multiples of billions, and both technical and economic issues are involved. An auction process dealing with the resulting complications has never existed anywhere, except perhaps on the pages of a scholarly journal.

Many alternative auction mechanisms were suggested by firms responding to a notice of proposed rule-making that was issued in November of 1993. The choice of mechanism is controversial because the outcome of the auction—who wins and who loses—will be influenced by its architecture. The future of the cellular phone industry as well as many associated industries hang in the balance.

One group of potential license buyers has argued that it should be possible to bid on a single package consisting of a license in each of the 51 MTAs, thereby creating the basis for a nationwide personal communication system under a single operator. A sealed bid process has been proposed. Other operators argue against such packaging and against sealed bids, claiming that all licenses should be auctioned simultaneously according to the rules of continuously operating, ascending price auctions. They argue that a simultaneous, continuous auction process would allow bidders to group licenses to fit unique geographic needs. As the bids increase in some areas they can immediately react by changing the nature of the areas in which they want to operate. These firms argue that the creation of any sort of pre-organized packages on the part of the government would preferentially advantage the firms that propose them.

Still other firms argue that the licenses should be auctioned one at a time, in a sequence starting with an auction of the most valuable licenses. They argue that bidders should be able to make sure that they own a license that is central to their own operations before becoming committed to the purchase of licenses in outlying areas. Still other possibilities exist.

Modern computerized, interactive mechanisms make possible auction processes in which bidders can make "contingent bids" of the sort "I will pay $X for license A if my bid of $Y for license B wins." It is also possible to design mechanisms in which bidders are allowed to submit bids on packages of their own design, and in which the computer sorts out packages that fit together and determines the high bidders at each stage of a continuous bidding process. Almost all of the proposals submitted in response to the 1993 notice of proposed rule-making were based in part on the modern theory of games, but the complexities are such that

differences of opinion regarding applications can easily exist—even among those who agree completely on the basic principles of the theory.

In January of 1994, representatives of the National Telecommunications Administration and the FCC met at the California Institute of Technology (Caltech) to study the operations of various auction processes operating in laboratory testbed environments. Caltech researchers, associated with the Caltech Laboratory for Experimental Economics and Political Science, had conducted experiments with many of the different auction systems and presented results to the government and industry officials as to how the various auction systems work. In some cases the representatives were able to participate as subjects so they could experience for themselves how such potentially complex auctions might be conducted.

The results of the experimental work were submitted to the FCC and studied extensively by governmental economists who then faced the task of using the data and existing theory to design a final auction mechanism. The Caltech data had demonstrated that proposals involving sequential auctions combined with a single national package of MTAs resulted in inefficient outcomes and a pattern of discrimination against certain types of participants. The experiments also demonstrated that concerns regarding complexity and the ability of humans to operate in an electronic marketplace of such magnitude were completely unfounded.

From the testbed research a new proposal has emerged from the FCC: a simultaneous, electronic auction that reflects the data presented at Caltech but also differs in substantial ways. Experimentalists are now busy creating more focused testbeds that work out some of the details of the process such as stopping rules, market feedback, and considerations of bidding flexibility. The new testbeds will challenge the proposed bidding mechanism and search for potential problems—ranging from possible theoretical inconsistencies to simple electronic "bugs"—before it is finally implemented. The laboratory experiments are likely to be followed by small scale field experiments. The technology must work and the economics must work, for the stakes are in the billions of dollars and no one wants to gamble on an untested mechanism.

The design and testing of processes aimed at solving complicated, socioeconomic problems involve exactly the types of problems in which laboratory testbed researchers deal. The FCC is not an isolated example. Laboratory experimental methods have been important in the development of mechanisms for the allocation of airport landing slots, the sources of electricity generation, air pollution rights and permits, access to natural gas pipeline networks, space station resources, procurement, antitrust issues, consumer economics (warranties and labels), and contingent valuation and environmental damage measurement, to mention but a few. The notion that laboratory experimental methods have a use in the economic policy process is now beginning to be accepted. The design of markets and process, beginning with first principles and followed by laboratory testing is actually happening. Through these methods, policy debates are guided by evidence and evidence backed by theory, and do not reflect simple opinion and rhetoric. Facts get involved, which to some observers of policy making, is a refreshing event. ■

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Editor's Message

Welcome to the second issue of the *HumanDimensions Quarterly!* This issue introduces a regular feature called Data and Information Availability. Its purpose is to highlight recently produced data resources and publications about human interactions in the environment. Your recommendations and comments regarding this feature are welcome, simply send them to Elaine Brown via electronic mail: elaine.brown@ciesin.org or telnet: hdq.ciesin.org or postal mail: CIESIN, Managing Editor, HDQ, P.O. Box 5903, Saginaw, MI 48603-9888 USA.